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Self-activating intelligent home using bluetooth

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Abstract Homes today need to exploit the various technologies available to make them intelligent. In this paper, a wireless system is proposed to automate home appliances using Bluetooth. This system can be used from a Bluetooth module that is closer than 10 meters to the system. Once in range, various appliances can be self-activated by the software that is built into a microcontroller. It is envisioned to offer automation of doors, lights and various electrical appliances. It also offers a complete user based automation for an improved personal experience.

1. Introduction

Home automation is built on the intention to make human lives better. With increased comfort, it is implicitly expected to utilize any advancement or improvement in technology, to improve the quality of living standards. It is a known fact that a dimmed light bulb will last longer than had it been used in the normal way. This concept of saving can be extended to various home appliances such as the air conditioner, thermostat, television, music system, fans or dimming the lights. Locking and unlocking the doors can be added to this setup and it is an added advantage. Home automation is currently being implemented in various homes and the number is rising continuously. Due to this trend, advancements in technology have become a necessity. Currently, there are numerous researches going on in this field to bring out Intelligent Homes. Bluetooth could well be the answer for that [1].

Bluetooth works in the 2.5Ghz unlicensed ISM band. This standard helps to connect devices - fixed and mobile - with the intention to offer faster adhoc connections. It also has in itself a fast authentication process which can be used when the Bluetooth modules are in the Bluetooth connectivity range of 10 meters. The transfer rate on these modules is 1Mbit/s. The self-activated connection initiation process takes place once these devices are within the discoverable range of each other. A Bluetooth module also has an inbuilt feature of saving other Bluetooth modules' identity. At any point in time, seven such modules can be connected to one Bluetooth module which is the master in this setup.

Bluetooth can be brought into the field of home automation due to its nature of lesser discovery time, fast connectivity, high data rate and low cost. The wireless nature of this technology makes this system keyless. An initial manual configuration must be completed for the setup to work seamlessly in future. Each configuration will be saved as a Bluetooth profile and will be used the next time the module connects to it.

2. Overview of the System

2.1 Control System

The Intelligent Home has a system that is controlled using a portable Bluetooth module. They are connected wirelessly. Once connected, the system will be able to control lights and appliances such as the television and the microwave. For every connection that is established, depending on the time of the day, it will be able to control the dimness of lights, the speed of the fan, the controls of the air conditioner, switching the television on and various other appliances[2][3]. In addition, it will also be able to open the door. This entry will be a keyless entry system into the home.

The user must initially setup the system by pairing a Bluetooth device. After connecting a Bluetooth device to the system, the user must define the configuration settings for every appliance individually. Once complete, the control system will remember the configuration for a particular user under a profile name. This can be extended to a total of seven Bluetooth devices. In case of conflicts, a user defined profile is chosen as the master profile with the highest priority. This master profile will have settings where there will be automation of appliances for the entire family.

2.2 Bluetooth Technology

Working in the 2.4GHz band, Bluetooth Technology has now become a technology that could well change the way we look at things. The highly cost effective technology is used on highly resource constrained devices such as a mobile phone. This works in an unlicensed band throughout the world. The Bluetooth range is about 10meters for a basic device with default setup, while this can be increased to about 100meters depending on the transceivers it is used with.

It also offers a secure channel for communication over short distances. Security is further enhanced by using a 64bit or 128bit encryption technique.

2.3 Arduino BT - Microcontroller

The microcontroller, as the name says, controls all the actions that will take place. It sends out instructions and also processes all information that is coming its way. Here we use Arduino BT (Bluetooth) for its small size and easier handling capabilities. It offers the ATMEGA328 microcontroller that has 14 I/O pins. In addition to that it also provides 2Kbytes of RAM for faster operations. It has 32Kbytes of storage capacity in it.

This microcontroller acts like the life-giving nature of the system. It sends and receives signal from the Bluetooth device that is in range. Once the Bluetooth device has been authenticated and connected, the microcontroller triggers options for various appliances to be controlled [4]. This Arduino BT board will be powered by a rechargeable battery that will always be connected to the power supply from the socket on the wall.

It also has the capability to detect the charge levels in the battery. And due to this functionality, it will be able to keep the user informed in case the battery charge drops to low levels.

The security aspect of this system has to also be considered. It takes note of repeated requests for authentication purposes. This can be a possibility of an external attack on the system and will be logged in the microcontroller. Once the system is connected by an authenticated user, this message will be forwarded to that user. Another possibility is a breakdown within the system itself. The microcontroller can be designed to send beacon signals to various connected devices, including the connected Bluetooth device, to make sure that these devices are working as intended. To add to this

feature, the microcontroller can connect to the devices that it can believe to be trusted. To do so, during the initial configuration stage, the microcontroller will send out a set of thirty codes that the device can use. These codes will be stored both in the user's device as well as the microcontroller. For validation purposes, the device can randomly choose one of these codes and send it to the microcontroller. Care is taken to see that, the device does not send the same code as used in the last twenty instances of authentication. These codes can be revised after every twenty valid established connections. To enhance this system, the Bluetooth device installed at home will be configured such that it is not discoverable by any other Bluetooth devices in its range [7].

2.4 Keyless Entry

Keyless entry is a comfort that is most sought these days. With this comes the risk of a system that is open due to negligence. Though a manual override will be available, the automatic keyless entry
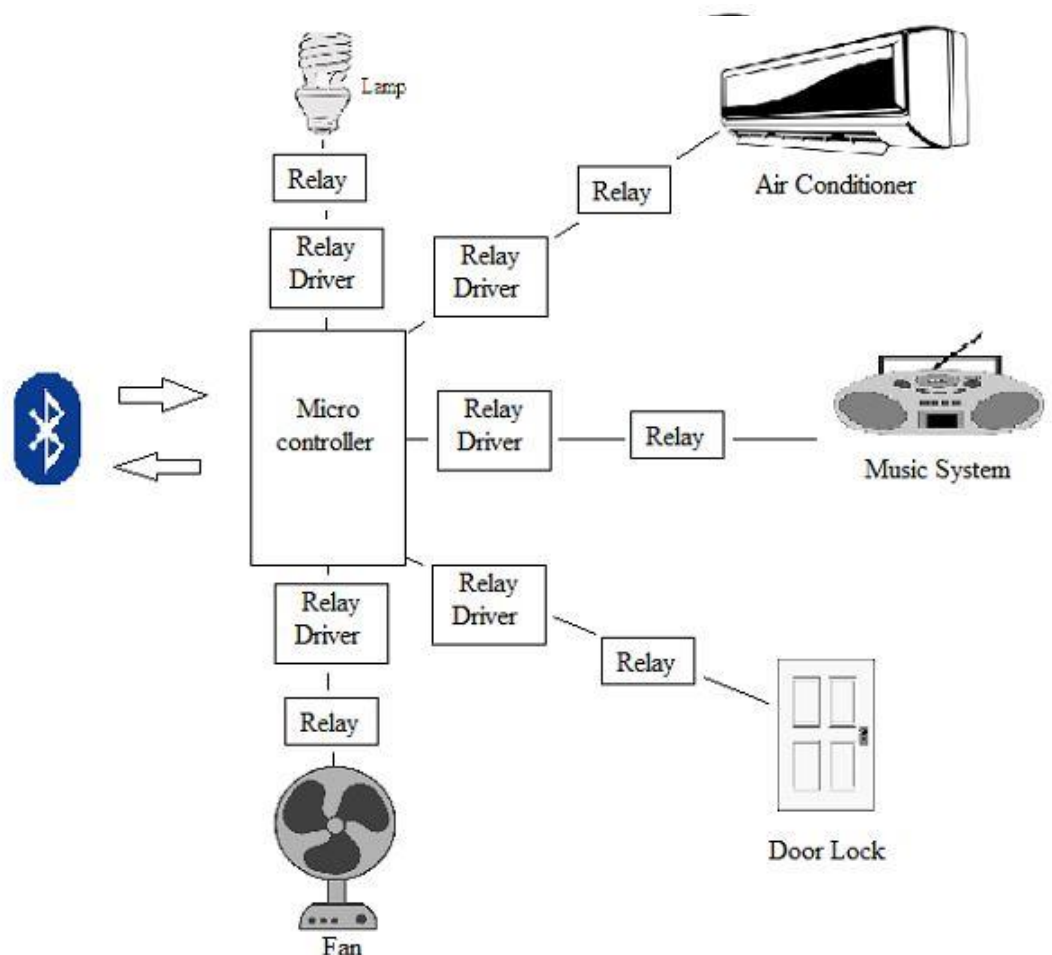
system will kick in once the user's device is in range and is connected. It must be to the preference of
Fig. 1 Block diagram of the Intelligent Home System

the user to let the user decide, if the keyless entry to the car parking space has to be activated every time the user is in range. Also, the user can define time constraints, only during which the keyless entry for the car parking space will work. These can be guaranteed for the days of the week as well. An override for this too can be provided to make the system efficient [9, 10].

Keyless entry to the home will be provided by the microcontroller. In both instance, it will send out an audio signal to inform that the door has been unlocked and also a message on the user's cell phone. To make the system secure, the door will be locked after fifteen seconds of being open. *2.5 Architecture of the System* The setup mainly consists of two Bluetooth modules, one with the user and the other at home. The one at home is constantly searching for incoming requests. This is connected to a microcontroller. All

the information received is sent to the microcontroller for further processing and appropriate action is taken. The microcontroller then sends out signals through the relay to the intended appliance. The system will continuously run to check for any incoming connections. If a user is within range and is connected by using one of the unique code available with it, the system kicks in with all the functions.[5] These codes will be available in the transmitting and the receiving sections of the system. The system must be capable of checking if an unused code alone is being used or not. It should also be noted that repeated usage of the same code must also be dealt with. Once authenticated, the system presents to the user all the options available to control the home appliances. As an added feature, it is possible to adjust the dimness of lights based on the time of the day and the user preference that was configured during the stages of initial adjustment.
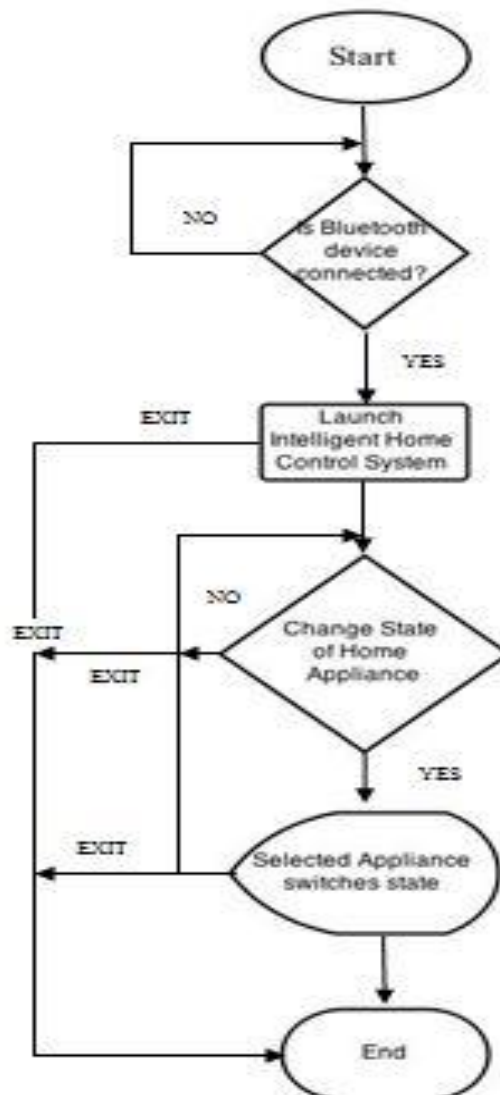

Fig. 2 Flowchart of a typical Intelligent Home.

An LCD will be available to display messages. Fig. 1 shows a block diagram of transmitter section. Here it is a simple setup with the Microcontroller and a Bluetooth device. In the user's environment, this could well be replaced with the user's Bluetooth enabled cell phone. [6]
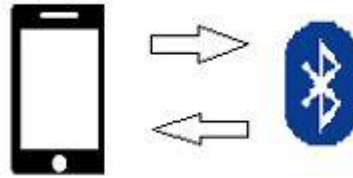

Fig. 3 Block Diagram of User's environment

2.5 Relays

Relay is nothing but a switch. These are basically used to pass or block a connection. This can also be implemented using software to send signals through these pins.

2.6 ATMEGA328 Microcontroller

Features:
- 32 Kbytes of Flash Memory
- 14 I/O Pins
- 2 Kbytes of SRAM
- Operating range of 2.5-12 volts

2.7 The Algorithm

The algorithm is as given in the flowchart in Fig. 2. This starts with the Bluetooth module being able to communicate with an authenticated user. Once that is complete, the user has a list of options to choose from as to what appliance does the user want to change the state of. If that completes, the display message will be available in the LCD. If the user leaves the environment, the entire setup terminates. In such a state, the system waits until an authneticated user communicates with the microcontroller again.

3. Conclusion

In this paper, a low cost, keyless Intelligent Home automation system has been proposed. This proposed system provides reliable security and access to authenticated users. It can also be used to switch the current state of any home appliance. This extension of the system to any other appliance has to be analyzed for efficiency and greater security. Future work includes developing the application for any Bluetooth enabled smart phone.

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